# Mechanical Function Check of the Inlabtec Serial Diluter Mixer

## 1 Introduction

This procedure provides a simple functional check of the Serial Diluter mixer using the existing device setup. A smartphone app is used to measure the mixer speed and mixing time. Completion of the full mixing operation at the specified speed and duration confirms that the mixer is operating with the defined key mechanical parameters.

Equipment that can affect test results must be verified before use in an accredited laboratory. For initial verification, results obtained with the Serial Diluter are compared with those from the laboratory's established serial dilution method, such as the tube and vortex method, using parallel aliquots of the same homogenized sample under otherwise consistent conditions.

After implementation of the Serial Diluter, maintaining filled dilution tubes and a separate vortex system solely for periodic checks may be impractical. The mechanical check described here provides indirect evidence of consistent mixer function but does not replace the comparative assessment of microbiological homogenization performance required by ISO 7218:2024, Clause 6.4.4.4. The microbiological assessment can be performed using the existing Serial Diluter setup by comparing microbial counts before and after additional manual mixing of the same bag contents (see "Verification of the Homogenization Performance of the Inlabtec Serial Diluter").

## 2 Measurement Principle

The smartphone accelerometer records the periodic movement of the bag holder during mixing. Each complete revolution of the eccentric wheel produces a characteristic acceleration peak. The mixing time t is determined from the beginning of the first peak to the end of the last peak. The number of peaks corresponds to the number of revolutions N. The rotational speed n is calculated as follows:

$$n = N/t \times 60$$

The measured mixing time and calculated rotational speed are then compared with the specified acceptance criteria. This confirms whether the mixer completes the intended mixing operation at a sufficient rotational speed.

## 3 Additional Material Required

- Smartphone with an accelerometer
- App *phyphox – Physical Phone Experiments* by RWTH Aachen University

Fig. 1: QR codes for the phyphox – Physical Phone Experiments app (RWTH Aachen University). Apple App Store on the left; Google Play Store on the right.

**4 Data Recording**

- Put the Serial Diluter UA or UC into operation, insert six bags and fill them with diluent, or prepare a complete dilution series.
- Open the *phyphox* app on the smartphone and select **Acceleration (without g)** under **Sensors**.
- Place the smartphone on the bag holder (Fig. 2).
- Start recording in *phyphox* by tapping the arrow button.
- Start the mixer:
  Serial Diluter UC: Press the **+** button in the **TIME** field.
  Serial Diluter UA: Briefly and carefully lift the dispensing lever while it is in the park position. As the measurement is very sensitive, move the dispensing lever as gently as possible to avoid additional interference signals.
- Activate the mixer approximately three times to record several measurement sequences and visually check their plausibility. Select one complete, interference-free and clearly evaluable sequence to calculate the mixing time and rotational speed. If visible differences occur between the sequences, repeat the measurement and investigate the cause.
- Stop recording on the smartphone.

Fig. 2: Smartphone placed on the bag holder and running the *phyphox* app during data recording.

**5 Data Selection and Evaluation**

- Tap **Multi** to display the measured accelerations for all axes (Fig. 3).
- Select **Pan/Zoom** and enlarge and move the graph to select one complete mixing operation (Fig. 4).
- Select **Pick point** and place the first measurement point at the beginning of the first peak. Record the displayed time t1.
- Place the second measurement point at the end of the last peak and record the displayed time t2.

**Note:** You can switch between **Pan/Zoom** and **Pick point** to position the measurement points precisely.

- Count the number of peaks or revolutions N within the selected measurement sequence.
- Calculate the mixing time t and rotational speed n:

$$t = t2 - t1$$

$$n = N/t \times 60$$

Calculation example based on the measurement data in Figs. 4 and 5:

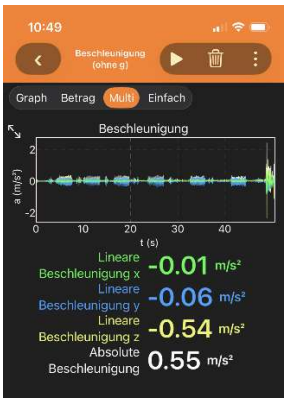


Fig. 3: Acceleration data recorded with the *phyphox* app shown in the Multi-mode.

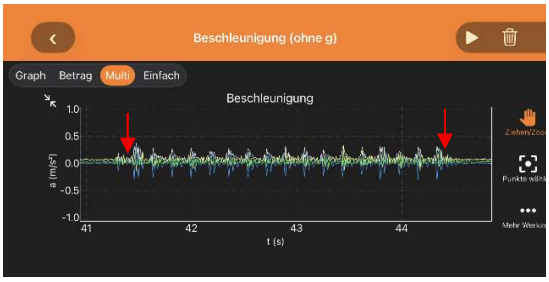


Fig. 4: Selection of one complete mixing operation using Pan/Zoom. Seventeen peaks or revolutions are counted within the selected sequence.

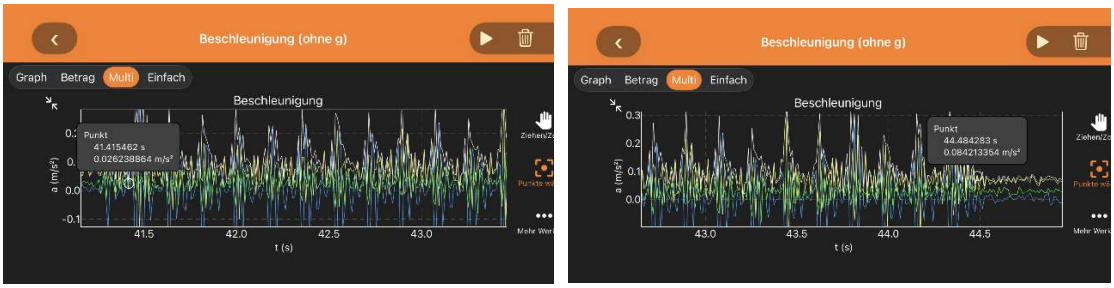


Fig. 5: The sequence is enlarged using Pan/Zoom. Pick point is used to determine the start time t1 = 41.41 s (left) and end time t2 = 44.48 s (right).

Mixing time t = t2 − t1 = 44.48 s − 41.41 s = 3.07 s (see Fig. 5)
Number of revolutions N = 17 (see Fig. 4)

Rotational speed n = N/t × 60 = 17/3.07 × 60 = 332 $min^{-1}$ (332 rpm)

**6 Acceptance Criteria**
The mixer function check is passed if:

*The measured mixing time t must be within 0 to +0.5 s of the set mixing time and the calculated rotational speed n is greater than 300 $min^{-1}$ (300 rpm).*

In the example, the set mixing time is 3.0 s. With a measured mixing time t of 3.07 s and a calculated rotational speed n of 332 $min^{-1}$, both acceptance criteria are met.

**7 Interpretation**
If the mixing time and rotational speed are within the specified acceptance ranges, the mixer is operating with the specified key mechanical parameters under the conditions tested. The result confirms the proper mechanical function of the mixer and may be documented as a periodic functional check.

If an acceptance criterion is not met, repeat the measurement. In particular, check the set mixing time, selection of the measurement sequence and correct counting of the peaks.

If the repeated measurement confirms the deviation, check the device settings, eccentric movement and mechanical function of the mixer. The device should not be used for routine examinations until the issue has been resolved. Contact Inlabtec Service if necessary.

**8 Documentation**
The following information must be documented:
- Serial Diluter model and serial number
- Date and responsible person
- Smartphone model and version of the *phyphox* app
- Device configuration, number of bags and their fill volume
- Set mixing time
- Start time t1, end time t2 and calculated mixing time t
- Number of peaks or revolutions N
- Calculated rotational speed n
- Number of recorded mixing operations or measurement sequences
- Acceptance criteria applied
- Assessment: acceptance criteria met/not met
- Deviations, repeated measurements and actions taken

The evaluated measurement graph should be retained with the test record as a screenshot or exported file. This ensures traceability of the measurement values and the selected measurement sequence.

**9 References**
1. ISO 7218:2024. *Microbiology of the food chain — General requirements and guidance for microbiological examinations.* Clause 6.4.4, in particular 6.4.4.4, “Calibration and verification“.

2. ISO/IEC 17025:2017. *General requirements for the competence of testing and calibration laboratories.* Clause 6.4, “Equipment”.
3. Staacks, S., Hütz, S., Heinke, H. and Stampfer, C. (2018). “Advanced tools for smartphone-based experiments: phyphox.” *Physics Education*, 53(4), 045009. DOI: 10.1088/1361-6552/aac05e.
4. RWTH Aachen University. *phyphox – Physical Phone Experiments.* https://phyphox.org.